Development of a Composite Reinforced Aluminum Conductor

Contract #: 500-98-035
Contractor: W. Brandt Goldsworthy & Associates, Inc.
Contract Amount: $75,000
Match Amount: $65,000
Contractor Project Manager: Clem Hiel (626) 351-2082
Commission Contract Manager: Linda Davis (916) 654-3848
Status: Completed

Project Description:
The purpose of this project is to improve the reliability and capability of California's transmission and distribution system by developing a stronger and lighter conductor to replace these aging and overloaded power lines. Specifically, this project will develop a composite reinforced aluminum conductor (CRAC) to replace conventional conductors made from aluminum wires wrapped over a core of steel strands (called aluminum conductor - steel reinforced (ACSR) conductors). Many miles of California's overhead electricity transmission lines have reached the end of their service lives or are being stressed beyond their design limits due to load growth and heavy power transfers across longer distances. This technical development is very timely as the current age of transmission lines ranges from 30 – 70 years.

W. Brandt Goldsworthy and Associates, Inc. of Torrance, CA, with additional match-funding support from the DOE and private industry, is reconfiguring aluminum conductors around a lightweight composite strength member whose weight is approximately 25 percent of the traditional steel strength member. The resulting lightweight conductor can be optimized for reduced sag and increased ampacity. CRAC conductors can withstand adverse weather and high load conditions, thereby avoiding power outages caused by line sagging and swinging, high winds and ice buildup.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by avoiding power outages caused by line sagging and swinging, high winds and ice buildup.
- Improving the energy cost/value of California's electricity by reducing losses and the costs of replacing conductors.
- Improving the environmental and public health costs/risks of California's electricity by reducing the need for new transmission lines.
- Improving the safety of California's electricity by significantly reducing the potential for line clearance violations.

Proposed Outcomes:

1. Design, fabricate and test a robust, practical and cost-effective composite reinforced aluminum conductor.
2. Target market price for CRAC is $1.00 per product pound, which is approximately the cost of aluminum conductors which are steel reinforced.
3. Five percent more electrical conductivity, compared to steel reinforced aluminum conductor.
4. Reduced mechanical elongation (line sag) at high operating temperatures.
5. 250 percent stronger than steel reinforced aluminum conductor.
6. 75 percent lighter than steel reinforced aluminum conductor.

Actual Outcomes:

1. Two CRAC, CRAC-121 (one-to-one) and CRAC-Advanced, were developed during this project. Both achieved:
   - Five percent more electrical conductivity than DRAKE.
   - A minimum of 40 percent more ampacity than DRAKE.
   - Twenty percent less mechanical elongation at ambient operating temperatures.
   - A 30 percent strength increase compared to DRAKE.
   - Only a 25 percent weight reduction was achieved and the objective of a 66 percent reduction was not met. In retrospect, this turned out to be an ill-posed objective because the maximum possible weight reduction, achieved by taking all the steel out of the DRAKE conductor, is only 33 percent.
2. Splicing techniques were developed and demonstrated for both CRAC.
3. A splicing tool was developed to splice the composite strength member.
4. There were two very positive unanticipated outcomes.
   - CRAC conductors were found to operate 9 (CRAC-121) to 25 percent (CRAC Advanced) cooler than ACSR conductors.
     - Both conductor designs can carry optical fibers in the hollow center. When optical fibers are added, these conductors are called CRAC-TelePower.

Project Status:

The project has been completed. For the final report, please right click on www.energy.ca.gov/pier/final_project_reports/600-00-040.html